ACRYLAMIDE

Acrylamide is a federal hazardous air pollutant and was identified as a toxic air contaminant in April 1993 under AB 2728.

CAS Registry Number: 79-06-1 $CH_2CHC(O)NH_2$

Molecular Formula: C_3H_5NO

Acrylamide occurs in crystalline form and in aqueous solutions. The crystalline monomer is a colorless-to-white, free-flowing crystal that is very soluble in water, alcohol and ether, and is insoluble in benzene and heptane. It is stable at room temperature, but may polymerize violently when melted or in contact with oxidizing agents and under ultra-violet light. When heated to decomposition, acrylamide emits acrid fumes and nitrogen oxides. The polymer exists in many forms, soluble and insoluble in water. The 50 percent aqueous form is the preferred form for industrial applications in which water can be tolerated (NTP, 1991).

Physical Properties of Acrylamide

Synonyms: propenamide; acrylic amide; ethylenecarboxamide; 2-propenamide

Molecular Weight:	71.08
Boiling Point:	125 °C at 25 mm Hg
Melting Point:	84.5 °C
Vapor Density:	2.45 (air = 1)
Density/Specific Gravity:	1.122 at 30/4 °C (water = 1)
Vapor Pressure:	0.007 mm Hg at 25 °C
Log Octanol/Water Partition Coefficient:	-0.67
Solubilities in g/100 ml solvent at 30 °C:	215.5 (Water) 155 (Methanol) 0.346 (Benzene)
Henry's Law Constant:	3.2×10^{-1} atm-m^3/mole
Conversion Factor:	1 ppm = 2.9 mg/m^3

(Howard, 1990; HSDB, 1991; Merck, 1983; Sax, 1989; U.S. EPA, 1994a)

SOURCES AND EMISSIONS

A. Sources

Acrylamide's primary use is as a chemical intermediate in the manufacture of polyacrylamides. It is also used in the synthesis of dyes, as a cross-linking agent, in soil conditioning agents, in flocculants, in sewage and waste treatment, in ore processing, in adhesives, in paper and textile coatings, and in permanent press fabrics. Acrylamide has also been used in the construction of dam foundations and tunnels (HSDB, 1991).

The primary stationary sources that have reported emissions of acrylamide in California are educational services, electronic component and accessories manufacturing, and manufacture of synthetic materials (ARB, 1997b).

B. Emissions

The total emissions of acrylamide from stationary sources in California are estimated to be at least 350 pounds per year, based on data reported under the Air Toxics “Hot Spots” Program (AB 2588) (ARB, 1997b).

C. Natural Occurrence

No information about the natural occurrence of acrylamide was found in the readily-available literature.

AMBIENT CONCENTRATIONS

No Air Resources Board data exist for ambient measurements of acrylamide.

INDOOR SOURCES AND CONCENTRATIONS

No information about the indoor sources and concentrations of acrylamide was found in the readily-available literature.

ATMOSPHERIC PERSISTENCE

Acrylamide in the vapor phase is expected to react with photochemically-produced hydroxyl radicals in the atmosphere. It is also expected to be scavenged by rain and fog due to its high solubility in water (Howard, 1990). No information was found on the atmospheric half-life and lifetime in the readily-available literature.

AB 2588 RISK ASSESSMENT INFORMATION

The Office of Environmental Health Hazard Assessment reviews risk assessments submitted under the Air Toxics "Hot Spots" Program (AB 2588). Of the risk assessments reviewed as of April 1996, acrylamide contributed to the total cancer risk in 3 of the 550 risk assessments reporting a total cancer risk equal to or greater than 1 in 1 million. Acrylamide also contributed to the total cancer risk in 1 of the approximately 130 risk assessments reporting a total cancer risk equal to or greater than 10 in 1 million (OEHHA, 1996a). For non-cancer effects, acrylamide did not contribute to a total chronic or acute hazard index greater than 1 in any of the risk assessments (OEHHA, 1996b).

HEALTH EFFECTS

Probable routes of human exposure to acrylamide are inhalation, ingestion, and dermal contact.

Non-Cancer: Acrylamide (when occurring as a monomer) is a potent neurotoxicant at low levels. Acute inhalation of acrylamide may cause central and peripheral nervous system damage in humans resulting in symptoms ranging from drowsiness to hallucinations. Chronic oral exposure in humans and animals has resulted in nerve damage accompanied by weakness and numbness in the extremities. Chronic dermal exposure in humans may cause a rash (U.S. EPA, 1994a).

A chronic non-cancer Reference Exposure Level (REL) of 0.7 micrograms per cubic meter ($\mu g/m^3$) is listed for acrylamide in the California Air Pollution Control Officers Association Air Toxics "Hot Spots" Program, Revised 1992 Risk Assessment Guidelines. The toxicological endpoint considered for chronic toxicity is the central or peripheral nervous system (CAPCOA, 1993). The United States Environmental Protection Agency (U.S. EPA) has not established a Reference Concentration (RfC) for acrylamide, but has established an oral Reference Dose (RfD) of 2×10^{-4} milligrams per kilogram per day, based on nerve damage in rats. The U.S. EPA estimates that consumption of this dose or less, over a lifetime, would not likely result in the occurrence of chronic, non-cancer effects (U.S. EPA, 1994a).

No information is available on adverse reproductive effects in humans from exposure to acrylamide. Numerous studies in male mice and rats by oral, dermal, and injection routes have observed dominant lethal effects (e.g. reduced fertility and pre- or post-implant loss). Testicular damage and damage to sperm have also been reported. Although some studies in female mice and rats have found adverse developmental or female reproductive effects, others have not (IARC, 1994a; HSDB, 1995).

Cancer: Evidence is limited regarding the carcinogenicity of acrylamide in humans. In rats orally exposed to acrylamide, significantly increased tumors at multiple sites have been

observed. In female rats, these include mammary tumors, central nervous system tumors, thyroid follicular tumors, and uterine adenocarcinomas. Male rats developed increased incidences of thyroid follicular tumors and scrotal mesothelioma (U.S. EPA, 1994a).

The U.S. EPA has classified acrylamide in Group B2: Probable human carcinogen. The U.S. EPA has calculated an inhalation unit risk estimate of 1.3×10^{-3} (microgram per cubic meter)$^{-1}$. The U.S. EPA estimates that if an individual were to breathe air containing acrylamide at 8×10^{-4} $\mu g/m^3$ over an entire lifetime, that person would theoretically have no more than a 1 in 1 million increased chance of developing cancer (U.S. EPA, 1994a). The International Agency for Research on Cancer has classified acrylamide in Group 2A: Probable human carcinogen, based on sufficient evidence in animals and limited evidence in humans (IARC, 1994a).

The State of California has determined under Proposition 65 that acrylamide is a carcinogen (CCR, 1996). The inhalation potency factor that has been used as a basis for regulatory action in California is 1.3×10^{-3} (microgram per cubic meter)$^{-1}$ (OEHHA, 1994). In other words, the potential excess cancer risk for a person exposed over a lifetime to 1 $\mu g/m^3$ of acrylamide is estimated to be no greater than 1,300 in 1 million. The oral potency factor that has been used as a basis for regulatory action in California is 4.5 (milligram per kilogram per day)$^{-1}$ (OEHHA, 1994).